Fiber Optic Sensors with Hydrophilic, Radionuclide-Selective Cladding for the Detection of Radionuclides in Water Supplies

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Problem Statement

OBJECTIVE:

To develop a fiber optic scintillator system with a radionuclide-selective cladding for use in the detection of radionuclide contamination in water supplies or wastewater streams.

WHY?

The current terrorist threat requires that vigilance be maintained on all avenues of attack to the United States, including the potential for attack on the country's food or water supplies.

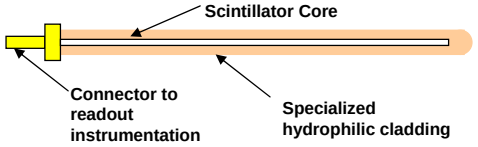
ADVANTAGES:

- *In-situ*, real-time monitoring
- "Instant" on-site detection ⇒ appropriate and timely emergency response.

Photo courtesy of Pacific Northwest National Laboratory

Technology Description

- Scintillating fiber optic core
  - Response proportional to radionuclide concentration
  - Easy detection of response
- Specialized cladding
  - Hydrophilic
  - Radionuclide selective
  - Preconcentrating



Summary of ^{99}Tc Uptake by Freestanding Hydrogel Films

ID	HEMA (%)	DEAE (%)	EGD (%)	Irgacure (%)	Weight Kd Result (ml/g)	RPD* (%)	Surface Area Kd Result (mL/cm^2)	RPD* (%)
ATC 1	100	0	0	1	No uptake		No uptake	
ATC 2	100	0	2	1	No uptake		No uptake	
ATC 3	100	0	5	1	728	83.4%	47	99.17%
ATC 4	100	0	10	1	No uptake		No uptake	
ATC 5	75	25	0	1	8636		253	
ATC 6	75	25	2	1	11752		292	
ATC 7	75	25	5	1	8086	98.5%	222	99.25%
ATC 8	75	25	10	1	3541		123	
ATC 9	50	50	0	1	11627	84.8%	400	80.26%
ATC 10	50	50	2	1	13063		436	
ATC 11	50	50	5	1	13056	87.2%	421	66.25%
ATC 12	50	50	10	1	18371		499	
ATC 13	25	75	0	1	17420		477	
ATC 14	25	75	2	1	22144		473	
ATC 15	25	75	5	1	17579	75.9%	387	66.66%
ATC 16	25	75	10	1	19919		476	
ATC 17	0	100	0	1	11043		324	
ATC 18	0	100	2	1	28594		325	
ATC 19	0	100	5	1	7929	92.9%	138	90.44%
ATC 20	0	100	10	1	7150		130	

* RPD = Relative percent difference for duplicate samples
* = (Absolute value (Kd1 - Kd2)) / (average Kd)

Expected Results

- Fiber optic scintillator with
  - Covalently bound hydrophilic cladding
  - Functionality capable of chelating radionuclides of interest
- Demonstration of fiber optic-based detection system
  - Controlled composition samples
  - Determination of detection limit
  - Parameters required for detection at drinking water levels

Additional Environmental Benefits

- Monitoring groundwater contamination
  - DOE facilities
  - Nuclear power generation facilities
  - Medical research facilities/landfills
- Monitoring of wastewater effluent
  - DOE facilities
  - Nuclear power generation facilities
  - Medical research facilities/landfills
- Leak Detection
  - DOE facilities
  - Nuclear power generation facilities
  - Medical research facilities/landfills

Radionuclide Analyte	DOE Site/Facility	Analysis Medium
Strontium 90	Hanford, INEEL	groundwater, process water, vadose zone, excavated soils
Technetium 99	Oak Ridge, Hanford	groundwater, surface water
Tritium	Hanford, Sandia, Nevada, Oakland	predominantly ground-water, sewage treatment plant influent

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